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Power Generation by Parabolic Mirror, Stirling Engine with Sunlight Tracking System

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Abstract: **-- Solar power generation had been employed as a renewable energy for years ago. Residents that use solar power as their alternative power supply will bring benefits to them. The main objective of this paper is to develop a microcontroller-based parabolic mirror tracking system which will keep the parabolic glass aligned with the Sun in order to maximize in harvesting power. When the intensity of light is decreasing, this system continuously changes its direction without any interruption. Microcontroller and stepper motor are used for continuous rotation for every one hour during day time only. This design is covered for a single axis and is designed for residential/small farmer use. Finally, the project is able to track and follow the Sun position in order to get maximum power at the output regardless motor speed.**

Keywords: **-- Renewable energy, parabolic mirror, Stirling engine.**

I. INTRODUCTION

Robert Stirling was the Scottish inventor of the first practical example of a closed cycle air engine in 1816, and it was suggested by Fleming Jenkins as early as 1884 that all such engines should therefore generically be called Stirling engines.

The closed cycle operation that the Stirling engine is an external combustion engine that isolates its working fluid from the energy input supplied by an external heat source. There are many possible implementations of the Stirling engine most of which fall into the category of reciprocating piston engine. Stirling engine should refer exclusively to a closed-cycle regenerative heat engine with a permanently gaseous working fluid, where closed-cycle is defined as a thermodynamic system in which the working fluid is permanently contained within the system and regenerative describes the use of a specific type of internal heat exchanger and thermal store, known as the regenerator.

In early years we used wood as a fuel. Now a days the majority of world people depends on fossil fuels such as coal, petroleum etc. The fuel is going too exhausted next few years. The burning of fossil fuels produces so many harmful gasses also NO2, SO2, CO etc which lead to negative environmental impact or pollute the entire atmosphere. In our non conventional sources like wind, solar, tidal, geothermal is pollution free but the installation cost will be high. In case of solar Energy the making of silicon wafers is quite expensive which is presently done by United States of America.
The above said non- conventional installation cost is not afford by Indian farmers.

II. EXISTING SYSTEM

In our existing system the Indian farmer receive power from go vernment or from private sector. The farmer should pay for consumed power for agriculture purpose. The farmer receives power from conventional or non conventio nal source. The conventional source are mainly called thermal where coal is used as a fuel sometimes it is import from otther country which is costly. Existing non conventio nal system consist of solar, wind, Geothermal and Tidal energy. The above said non conventional installation cost is very high, which is not afford by small farmers.

Existing Stirling Functional Description

The engine is designed so that the working gas is generally compressed in the colder portion of the engine and

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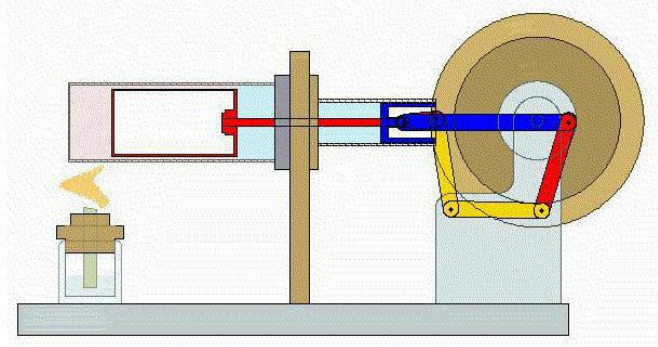


expanded in the hotter portion resulting in a net conversion of heat into work. An internal Regenerative heat exchanger i ncreases the Stirling engine's ther mal efficiency compared to simpler hot air engines lacking this feature.

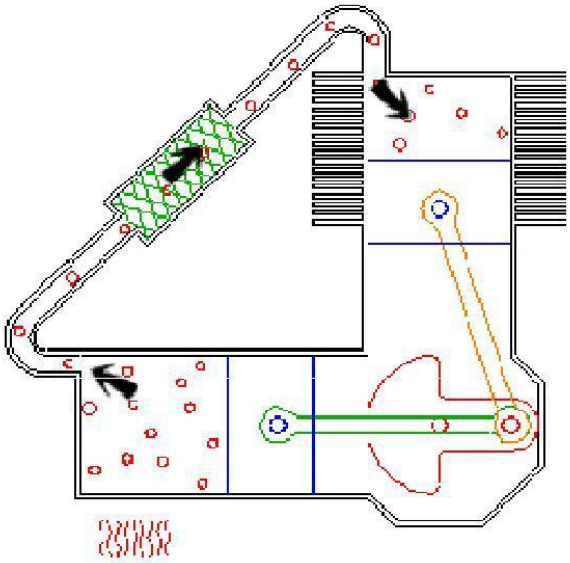
III. KEY COMPONENTS

Stirling engine design:
Pink – Hot cylinder wall
Cement color – Cold cylinder wall (with coolant inlet and outlet pipes in yellow)
White – Thermal insulation separating the two cylinder ends
Red color – Displacer pisto n

As a consequence of closed cycle operation, the heat driving a Stirling engine must be transmitted from a heat source to the working fluid by heat exchangers and finally to a heat sink. A Stirling engine system has at least one heat source, one heat sink and up to five heat exchangers. Some types may combine or dispense with some of these.

IV. REASONS TO USE STIRLING ENGINE

One reason is that for this kind of engine it's almost impossible to explode. You don't have to produce steam in a high pressure boiler. And inside the cylinder there are no explosions n eeded to run the pistons like in an Otto or Diesel engine. There are no ignitions, no carburetion because you only need one kind of gas and no valve train because there are no valves. This was a big advantag e to the steam engines in the days when Stirling invented his engine because it was much less dangerous to work next to a Sterling Engine than to a common steam engine. Inside the pistons can be used air, helium, nitrogen or hydrogen and you don't have to refill it because it uses always the same body of gas. The external combustion process can be designed as a continuous process, so the most types of emissions can be reduced. If heat comes from a renewable energy source they produce no emissions. They run very silent and they don't need any air supply. That's why they are used in lot of submarines.



Tracking system The project uses a solar panel coupled to a stepper motor to track the Sun so that maximum sun light is incident upon the panel at any given time of the day. This is better compared to light sensing method that may not be accurate always for example during cloudy days.

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With the impending scarcity of nonrenewable resources, people are considering to use alternate sources of energy. From all other available resources sun energy is the most abundant and it's comparatively easy to convert it to electrical energy. Use of solar panel to convert sun's energy to electrical is very popular, but due to transition of the Sun from east to west the fixed solar panel may be able to generate optimum energy. The proposed system solves the problem by an arrangement for the solar panel to track the Sun.

This tracking movement is achieved by coupling a stepper motor to the solar panel such that the panel maintains its face always perpendicular to the Sun to generate maximum energy. This is achieved by using a programmed microcontroller to deliver stepped pulses in periodical time intervals for the stepper motor to rotate the mounted panel as desired. The microcontroller used in this project is from 8051 family. The stepper motor is driven by an interfacing IC as the controller is not capable of handling the power requirements of the stepper motor. The project is provided with a dummy solar panel which can be used for demonstration purpose only.

Further the project can be enhanced by using RTC (Real Time Clock) to follow the Sun. This helps in maintaining the required position of the panel even if the power is interrupted for some time. View of Stirling Engine.

V. SPEED ANALYSIS

We are going to show the speed analysis of Stirling engine with the working fluid as air and nitrogen. In both case we give the heat for 240 seconds.

With air it runs for 360 seconds only and speed increases slowly and takes some time to reach saturation point.

With nitrogen it runs for 480 seconds and also the speed value increases rapidly and reaches the saturation point (ie.800 rpm) quickly and withstand for a long time.The graph is shown below, from the we can know that the withstanding capability of nitrogen as a working fluid is more when compare to air.Nitrogen's characteristics is similar to that of the air characteristics but its Withstanding capability is more, this is the main advantage of nitrogen. The cost of nitrogen is less.

Hardware Requirements

8051 series Microcontroller, Dummy Solar Panel, Stepper Motor, Voltage Regulator, Diodes, Relay driver IC, Transformer.

Software Requirements

Keil compiler
Languages: Embedded C or Assembly

Proposed System

In our proposed system we use Stirling engine, parabolic mirror used to produce power to small farmers. The installation cost is very low as compared to existing non conventional system .The existing system material is easily available in our local market. The designing circuit (tracking system) of our system is simple. The power is available during day time. Once installed the power is produced during long time. The per square meter power production of parabolic mirror is more than that of solar panel.

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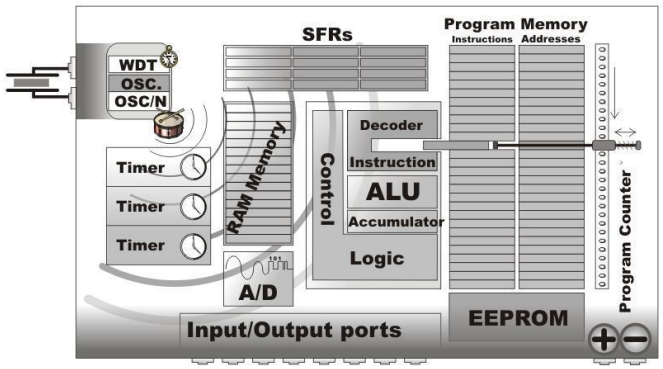
Parabolic Glass

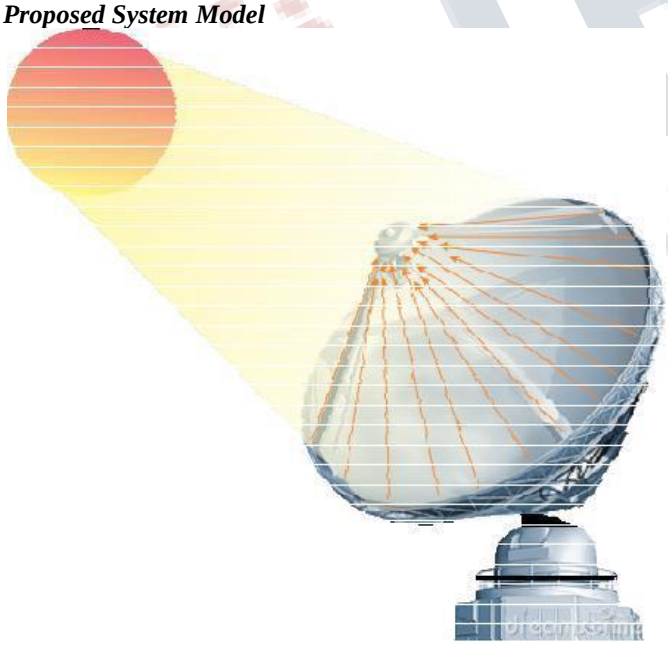
The above said parabolic glass is easily available in our local market. The cost of the parabolic glass is less as compare to solar panel. If it is compare in terms of manufacturing process again the parabolic glass is less because there is no use of any silicon diode in the above said glass. More over the extraction process is highly expensive which is presently done by United States of America.

Microcontroller



Proposed

Proposed System Model



In our proposed system the parabolic disc rotate at 180˚ with respect to the sun rotation. In this type of tracking is independent of light intensity. By the use of microcontroller and stepper motor the parabolic disc is rotating at 15° in every one hour.

VI. CONCLUSION

Our parabolic system is a gearless system. Moreover the parabolic mirror is 45 cm in diameter produce power hardly produce 400 W by using low temperature stirling engine. For 1 KW power we need complex gear arrangement. For real time project it is difficult to shift from one place to another.

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